DOCUMENT RESUME

ED 301 869 CS 009 453

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TITLE Attentional Capacity Allocation while Reading Easy and Difficult Text.
PUB DATE 13 Aug 88
NOTE 12p.; Paper presented at the Annual Meeting of the American Psychological Association (96th, Atlanta, GA, August 12-16, 1988).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Attention; Cues; Reading Rate; Reading Research; Responses
IDENTIFIERS Attention Theory; *Reading Behavior; *Text Factors; Text Processing (Reading)

ABSTRACT

To examine the difference in attention capacity when reading difficult or easy text, a study presented text that varied in difficulty to 22 subjects via a computer monitor. The text was presented in a self-paced manner, one word at a time. Reading times for each word were obtained by computing latencies between key presses. Whenever a flashing visual probe appeared on the screen, subjects pressed a second key. Latencies from probe onset to response were computed. Subjects read 12 passages, 6 difficult and 6 easy (rated by non-participating subjects). Passages were randomized and subjects were responsible for answering four comprehension questions following each passage. Interspersed within each passage were eight predesignated target words on which the probe was presented. Target words were matched for word frequency, length, and number of syllables across the easy and difficult passages. A second experiment used the same procedure except that the probe type varied. In half of the passages, the probe was presented visually as before, while in the other half the probe was presented auditorily (a 1000 Hz tone). Results revealed that response latencies to both auditory and visual probes were longer when the probes were presented in difficult text than when presented in easy text. The attentional capacity demands of difficult texts were shown to be greater than those of easy texts irrespective of the modality in which the probes were presented. (Two tables of data and one figure are appended.) (MM)

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Attentional Capacity Allocation while Reading Easy and Difficult Text

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Paper given as Poster at APA Convention

Sunday, August 13, 1988

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CS009453

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Abstract

Attention is believed to have a limited capacity. Tasks which make heavy demands on that capacity have been shown to produce longer response latencies to secondary task probes. Two experiments were conducted in which subjects read short passages that varied in difficulty. Response latencies to both auditory and visual probes were found to be longer when the probes were presented in difficult text than when presented in easy text. The attentional capacity demands of difficult texts are shown to be greater than those of easy texts irrespective of the modality in which the probes are presented.

Attentional Capacity Allocation while Reading Easy and Difficult Text

The relative amount of attention being devoted to a task is often measured through response latencies to randomly inserted probes. The more demanding the task, the longer the response latencies to the probe. The present investigation is concerned with response latencies to probes presented during the reading of easy and difficult text. Based on the hypothesis that attention has a limited capacity, relatively longer response latencies are predicted when probes are presented in difficult texts as opposed to easy texts.

There is ample reason to suppose that attention has a limited capacity based on response latencies to probes. Furthermore, investigations by Britton and colleagues (1978, 1981, and 1982) have isolated a variety of text characteristics which influence the allocation of attention while reading. When subjects are instructed to allocate more attention to the reading of text, response latencies to randomly inserted auditory probes are found to increase (Britton and Price, 1981). When the syntactical complexity of the text is raised, response latencies are found to increase (Britton et al, 1982). When cues indicating transitions between propositions (cues such as: therefore, moreover, in contrast) are minimized, response latencies are also found to increase (Britton et al, 1982). These results appear to uniformly support the proposition that attention has a limited capacity.

In apparent contradiction to the findings above, however, Britton et al. (1978) report that raising the difficulty of the text does not place greater demands upon attention, as indicated by shorter response latencies to probes presented during the reading of difficult text. The present investigation brings these results into question because it is probable that Britton et al.'s (1978) findings are confounded by re-reading under their experimental conditions.

Studies monitoring eye-movements have indicated that subjects will often regress to previous points in the text in order to clarify ambiguities (Carpenter and Daneman, 1981; Inhoff, 1983). Since Britton et al. (1978) presented the auditory probes at random times during the reading of the text and did not control for the possibility that subjects may re-read lines, it is likely that the shorter response latencies were the product of more frequent re-readings of lines in difficult text. The contradictory findings reported by Britton et al. (1978) may thus be explained by the fact that the re-reading of a sentence requires less attentional capacity than the reading of a sentence for the first time.

Three questions will be addressed by the present investigation. The first question concerns the assumption that re-reading text requires less capacity than the initial reading. Longer response latencies are predicted during the initial reading relative to the re-reading of the text. The second question asks whether difficult text will produce longer response latencies, as predicted by the limited capacity hypothesis, when subjects are prevented from

re-reading the text. Because difficult text intuitively demands more attention, it is likely that the response latencies to probes presented during difficult text will be longer when re-reading is prevented. Such a result would confirm the suspicion that Britton's (1978) result was confounded by re-reading.

The final question pertains to the modality in which the probe is delivered. Are there differences in response latency to probes presented in the visual as opposed to the auditory sense modality? No interactions with text difficulty are predicted; the response latencies will be longer during the reading of difficult text regardless of the modality in which the probes are delivered. However, absolute differences in response latency may emerge across these modalities.

Method

In Experiment 1, text that varied in difficulty was presented to 22 subjects via a computer monitor. The text was presented in a self-paced manner one word at a time. Only one word was on the screen at any time. Subjects pressed a key with their left hand to update the text. Reading times for each word were obtained by computing the latencies between key presses. With their right hand, subjects pressed a second key whenever a flashing visual probe appeared on the screen. Latencies from probe onset to response were computed.

Subjects read twelve passages; six of which were rated by non-participating subjects as "difficult," and six of which were rated as "easy." The passages were randomized and subjects were responsible for answering four comprehension questions following

each passage. Interspersed within each passage were eight predesignated target words on which the probe was presented. These target words were matched for word frequency, length, and number of syllables across the easy and difficult passages. A 2 by 2 ANOVA was performed on the probe detection latencies with factors for word type (function versus content) and text type (easy versus difficult).

In Experiment 2, the same procedure was used only this time the probe type was varied. In half of the passages, the probe was presented visually as before, while in the other half of the passages, the probe was presented auditorily in the form of a 1000 Hz tone. A 2 by 2 by 2 ANOVA incorporating this additional factor of probe type (visual versus auditory) was performed on the probe detection latencies. Twenty subjects were run.

A final study was conducted in order to support the claim that the re-reading of difficult text requires less attentional capacity than the initial reading. Five subjects read and re-read the difficult texts used previously under similar conditions. Probe detection latencies, along with reading times for the target words, were recorded and analyzed.

Results

The mean probe detection latencies for the initial reading and the re-reading of difficult text were 562 ms and 533 ms respectively, $t(4) = 3.065$, $p < .05$. The mean reading times for across these conditions were 628 ms and 540 ms respectively.

The mean probe detection latencies during the reading of easy and difficult text in Experiment 1 were 586ms and 626ms respectively, $F(1,21) = 31.09$, $p < .001$. The same latencies in Experiment 2, when collapsed across probe type, were 488ms and 505ms respectively; $F(1,19)=16.74$, $p<.001$. Reading times in Experiment 1 across easy and difficult texts showed a similar trend with means of 394 ms and 448 ms respectively.

The probe detection latencies, collapsed across text type, following auditory and visual probes were 478 ms and 515 ms respectively; $F(1,19) = 25.67$, $p < .001$, and the interaction of probe type with text type was not significant, $p > .05$.

Conclusions

The data indicate that, indeed, when re-reading is prohibited, more attentional capacity is allocated during the reading of difficult text. This is supported by the longer probe detection latencies for difficult text as well as the longer reading times. The non-intuitive results reported by Britton et al. (1978) appear to be confounded by re-reading when re-reading was not prevented.

The data also indicate that responses to auditory probes are made more quickly under these experimental conditions than responses to visual probes. This difference may be attributed to interference within the visual sense modality because the visual probe competes with the visual text for attentional capacity. The auditory probe, on the other hand, does not compete with the visually presented text. This evidence argues for a modality specific pool of attentional

capacity. However, a modality inspecific pool of attentional capacity is also made plausible by the lack of interaction between text type and probe type. Difficult text requires more capacity than easy text irrespective of the modality in which the probe is presented.

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Table 1.

TABLE SHOWS PROBE REACTION TIMES AND WORD READING TIMES FOR INITIAL READING AND RE-READING OF DIFFICULT TEXTS.

	PROBE RT	READING TIME
INITIAL READING	562 ms*	628 ms
RE-READING	533 ms*	540 ms

n = 5

* $t(4) = 3.065, p < .05$

Table 2.

TABLE SHOWS PROBE REACTION TIMES AND WORD READING TIMES ACROSS EASY AND DIFFICULT TEXTS.

	PROBE RT	READING TIME
TEXT TYPE		
EASY	586 ms*	394 ms
DIFFICULT	626 ms*	448 ms

N = 22

* $F(1, 21) = 31.09, p < .001$

Figure 1.

GRAPH SHOWS PROBE REACTION TIMES TO AUDITORY AND VISUAL PROBES ACROSS EASY AND DIFFICULT TEXTS.